Roads Crossing Streams: Density

This EnviroAtlas national map displays the density of stream-road crossings per stream kilometer (or the average number of road-stream crossings per stream kilometer within each 12-digit hydrologic unit [HUC]) in 2011 using a medium-resolution (1:100,000) streams flowlines database.

Why are roads crossing streams important?

Roads are often built to follow stream networks, especially in hilly or mountainous terrain. Roads on the mid- and upper slopes of watersheds tend to cross tributary streams whereas roads lower in the watershed frequently run parallel to main channels. Each road type and location in the watershed has distinct interactions with streams and nearby terrestrial areas.[1] The largest overall effect of roads in watersheds is habitat fragmentation, where continuous habitat is divided into smaller patches. Habitat fragmentation can result in increased disturbance, predation, and isolation of wildlife species, leading to reduced wildlife populations and subsequent declines or local extinctions of sensitive species, such as neotropical migrant songbirds, small mammals, and amphibians.[2]

Aquatic organisms have evolved with a natural stream disturbance pattern of flooding and debris flows that rearrange gravel bars, backwater channels, and woody debris—all important features of aquatic habitat. However, research has shown that road networks in watersheds have increased the occurrence of peak flows and flooding as well as landslides and debris flows.[1] The road itself may be a source of debris flows or a barrier to the movement of sediment, debris, and water. Though bridges may be built over larger streams, culverts are more common for crossings on both primary and secondary roads. To be conservative of stream and riparian function, culverts must be designed to allow free passage of water, woody debris, and wildlife. Ideally, they need to be as wide as the maximum flow of the stream, on the same slope gradient, and submerged into the stream bed to avoid perching above the flow.[3] One of the biggest sources of excess sediment in watersheds is the diversion of streams caused by clogged culverts.[1]

Functional culverts are most important to maintaining necessary movements of aquatic organisms (e.g., fish and amphibians) for foraging, dispersal, and reproduction. Clogged, perched, or undersized culverts can all serve as impassable barriers to wildlife movements.[3] The effects of road crossings on fish passage differ by slope, fish species size and swimming ability, and culvert type and condition. Strong swimmers like salmon may be able to leap upstream through perched culverts, but smaller fish and weaker swimmers (e.g., sunfish, dace, and shiners) may find upstream movement through culverts difficult or impossible.[4] A recent survey in the Great Plains found that half of the surveyed culverts were complete barriers to fish passage.

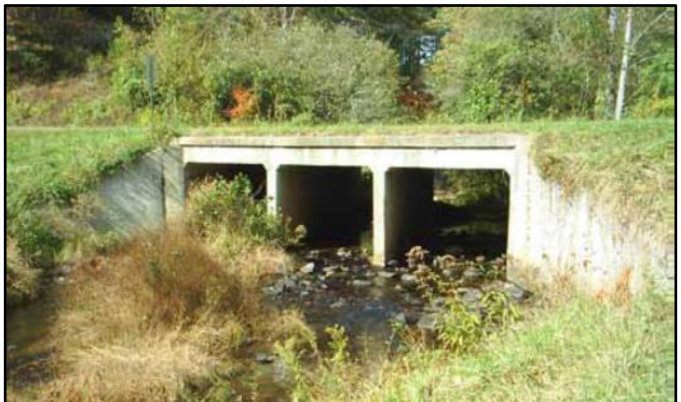
Photo: Road culvert designed for fish and wildlife passage, USFWS

Road (and associated roadside ditch) intersections with streams and flooding events or debris flows on or near streams are major avenues for the expansion of invasive plant species along road networks. The general pattern of invasion advances in both directions along roadsides and moves down the stream channel via flowing water or on fresh soil and gravel carried by debris flows.[5]

Though road reconstruction or restoration may be expensive, strategies have been developed for redesigning roads to help restore riparian ecosystem function and water quality. For example, older roads were designed to channel ditch drainage directly into streams. Roads like these may be redesigned with sediment traps to hold storm water and settling basins where sediment- and pollutant-laden water can percolate through soil to be filtered before entering the stream.[6] Failing and undersized culverts and bridges may be prioritized and replaced by updated culvert or open box crossings that match stream slope, width, and maximum flow to assure optimal wildlife and fish passage.[3]

How can I use this information?

This EnviroAtlas national map estimates the average number of road-stream crossings per stream kilometer within each 12-

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digit hydrologic unit in the conterminous U.S. for 2011. It is one of a series of national scale maps related to road density, roads near streams, and roads crossing streams in each HUC. This layer can be compared to other layers showing road density, number of road crossings, and the proximity of roads to streams in each HUC to assess the relative impact of roads as a landscape stressor. Lower road densities and numbers of road/stream crossings may indicate the existence of parcels within HUCs that may serve as candidates for restoration or preservation. HUCs with high road densities and crossings may be assessed further to prioritize problem crossings.

An EnviroAtlas user may overlay either of the roads crossing streams maps on an aerial imagery basemap and zoom in to see the character of the landscape and the land use pattern within specific HUCs. One can add other near-streams map layers such as land cover in riparian buffers, estimated floodplains, or land cover in floodplains.

How were the data for this map created?

These data were created using the National Hydrography Dataset Plus (NHDPlus V2) medium-resolution (1:100,000) flowlines and the Watershed Boundary Dataset snapshot for 12-digit HUC boundaries. The total length of all flowlines in kilometers was calculated for each 12-digit HUC. The road lines data came from the 2011 NAVTEQ roads data. The metric for roads crossing streams was based a count of point intersections between the NAVTEQ roads and NHD streamlines. The density of roads crossing streams is the calculated average number of road-stream crossings per stream kilometer within each 12-digit hydrologic unit. The road density, roads near streams, and roads crossing streams metrics were generated using the Analytical Tools Interface for Landscape Assessment (ATtILA) toolbox, an Esri ArcGIS toolbox created by EPA, that calculates many commonly used landscape metrics. For more detailed information on how the metrics were created, see the see the metadata and the ATtILA user's manual.

What are the limitations of these data?

Calculations based on these data are estimations. The mapped data can be used to inform further investigation. Periodic updates to EnviroAtlas will reflect improvements to nationally available data.

Stream length and density varies along artificial lines (e.g., state lines) in some regions due to differences in how streams were recorded. This can result in mapped areas with higher or lower stream density than surrounding areas. Not all intermittent streams are recorded, and streams can migrate or dry up over time. Note: These data were created using the National Hydrography Dataset Plus (NHDPlus V2) medium-resolution (1:100,000) flowlines. Other stream-related map layers in EnviroAtlas, such as the Impaired Waters dataset and the associated Stream Length and Stream Density metrics use the National Hydrography Dataset Plus High-Resolution (1:24,000) (NHDPlusHR) data, meaning that those metrics are not directly comparable to the roads/streams group because of the differences in stream density depicted at each scale.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. The datasets used to calculate the streams and roads metrics can be downloaded from the websites hyperlinked in the fact sheet.

Where can I get more information?

There are numerous resources on roads near streams and road-stream crossings; a selection of these resources is listed below. To ask specific questions about this data layer, please contact the EnviroAtlas Team.

Acknowledgments

Don Ebert, EPA, created the data layers for the road density, roads near streams, and roads crossing streams maps. Sandra Bryce, Woolpert, Inc., wrote the data fact sheet.

Selected Publications

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3. Prowell, E.S., W.W. Duncan, and B. Albanese (eds.). 2012. Georgia's stream crossing handbook. United States Fish and Wildlife Service, Georgia Ecological Services, and Georgia Department of Natural Resources. 19 p.

4. Bouska, W., and C. P. Paukert. 2010. Road crossing designs and their impact on fish assemblages of Great Plains streams. *Transactions of the American Fisheries Society* 139(1):214–222.

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6. Swift, L.W., Jr., and R.G. Burns. 1999. The three Rs of roads: Redesign, reconstruction, and restoration. *Journal of Forestry* 97(8):41–44.